1- Facility planning & layouts

* - Economic activity centre: It is any entity occupying space
  - objective of layout planning → Facilitate work flow
    → Increase productivity of workers & equipment
  - Relayout → Changes in production volume
    → Changes in processes & technology
    → Changes in product

a Reasons for re-layout:
1- Congestion/Bad utilization of space
2- Excessive stock in process
3- Long distances in the work flow process
4- Bottlenecks
5- Qualified workers perform many simple operations
6- Accidents
7- Difficulty in controlling operations

* - Facility layout: It is physical arrangement of everything needed for best production of goods or delivering of services
  - Facility: It is the entity that facilitates the performance of any job as m/c tool, work centre, manufacturing cell, etc.

* Objectives of facility layout: (Department and people & equip. in dept.)
1- Sense of unity (feeling of being a unit of same objective)
2- Minimum movement of people, material & resources
3- Safety
4- Flexibity

* - Production rate = $\frac{\text{no. of units}}{\text{shift}}$
  - Productivity = $\frac{O/P}{I/P}$ (same period) for O/P side (η for I/P side)
  - Effectiveness → Quality, Quantity & time

*Factors affecting plant layout

1- Materials (physical for inventory, handling---etc.)
2- Machinery (specs for time & space)
3- Labor (For flexibility, productivity---etc)
4- Material handling
5- Waiting time (stock)
6- Auxiliary services (Related to worker, material, machinery ⇒ 30% of space)
7- The building
8- Future changes (Flexibility)

* Types of plant layout:

1- Fixed position plant layout: Product stays and resources move to it
2- Product_oriented plant layout: Machinery & materials are placed following the product path
3- Process_oriented plant layout: Machinery is placed according to processes & materials to them for batches
4- Cell layout: Hybrid lay out of product & process-oriented plant layouts to perform several processes in one cell

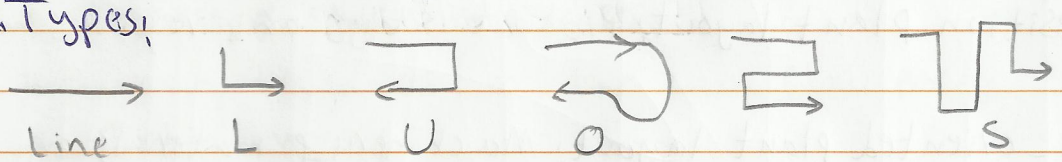
1- Product_oriented plant layout;

* - Product by product are produced
  - Machines are allocated next to each other in line in correct sequence of product manufacturing (very close)
  - Production process is organized in a continuous or repetitive way to avoid bottle necks ⇒ should be balanced (Pack different cubes in similar cubes and pack bigger first
  - specialized mcs are used

* Advantages:
  1- Less material handling activities
  2- Less work in process (stock for next step)(cross docking)
  3- Minimum manufacturing time
  4- Simplication of production planing & controlling

* Disadvantages:
  1- No flexibility
  2- High capital cost
  3- All workstations are critical to process
  4- Monotonous work

- Types:



2- Process- oriented plant layout

* - For batches production
  - Personnel & equipment of same function are allocated in same area
  - Motion is according to sequence of processes
  - Due to variety of products, several paths are considered (Espagetti)
  - Variation of production volume through time leads to modifications in quantities & types of products
  - General-purpose MCs are used

* Advantages:
  1- Flexible resources handling
  2- Low capital
  3- High labor intensity

* Disadvantages:
1- Low operations & material handling efficiency comparably but automation remove it
2- Low processing rates
3- Material handling costs are high
4- Total cycle time is high
5- Supervision is needed
6- High storage space
7- High capital costs

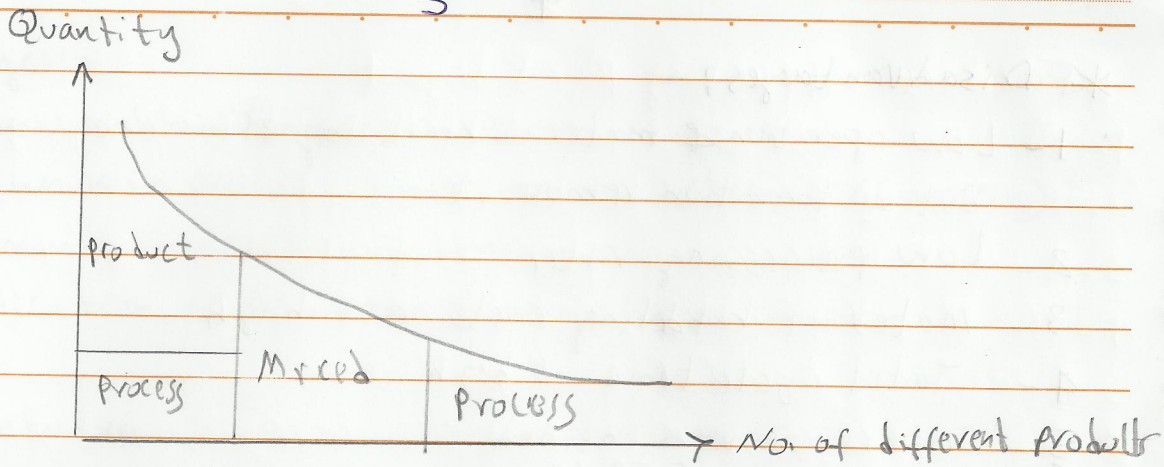
* - $S_t = S_e + S_g + S_v$

(S_t) Total space
(S_e) Static area (for equipment & workstations)
(S_g) Gravitation area (For tools and material for operator)
(S_v) Evolution area (For movements of operators & material)

- $S_g = S_e \times n$ → no. of accessible sides (as 3 for milling m/c)
  $S_v = (S_e + S_g)K = S_e(1+n)K$ → Industrial coefficient (0.05:3)

*

	Product-oriented	Process oriented
Description	Sequential	Functional
Type of processes	Continuous mass production	Instantaneous job production
Product	Standard (made to stock)	Varied (make to order
Demand	Stable	Fluctuating
Value	High	Low
Equipment	Special purpose	General purpose
Workers	Limited	Multi & skilled
Inventory	Low in price (High finished goods)	High in price (Low finished goods)
Storage space	Low	High
Material handling	Fixed path conveyors	Variable path
Aisles	Narrow	wide
scheduling	Should be balanced	Dynamic
Layout decision	Line balancing	Machinery location
Goal	Equalize work at each station	Minimize material handling cost
Advantage	Efficient	Flexible



* - $TTC = \sum t_{ij} d_{ij} C_{ij}$ → cost
  - Total transp costs
  - → Distance
  - → No. of sections
- No. of permutations = $\frac{n(n-1)}{2}$

3- Fixed position layout:

* - As surgery
- very high skilled labour
- Very high variable costs
- Low fixed costs

4- Cellular layout (work cells):

* - Group of equipment & workers that perform a sequence of operations over an item or multiple units as group technology
- Combines the advantages of product & process
  - [- Efficiency
  - → Flexibility
- Group technology → O/Ps of same characteristics are grouped to families & assign works and machines to these families and coded according to cell & mc

* Advantages

1- work-in-process inventory is low
2- Floor space is low
3- Reduced direct labor costs
4- High sense of participation
5- Reduced investmat in machinery & equipmnt
6- High equipmont utilizatim

- Position restrictions are considered

- Efficiency = $\frac{\text{Sum of tasks times}}{\text{Actual no. of wokers (Ns)} \times C}$

* Types of cellular manufacturing systems:

1- Decoupled CMS: There is temprory inventory between cells
2- Integrated CMS: cells are linked (self contained) as presence of assembly cell